

Background

Hurricane Georges caused widespread damage to Puerto Rico's electrical transmission and distribution systems. Entire sections of transmission and distribution lines were destroyed. All 78 municipalities were without electrical service although power generation equipment was relatively undamaged. Restoration efforts were hampered by Puerto Rico's mountainous terrain, which made it difficult to repair many of the transmission and distribution lines that provide service throughout the island. Initial restoration efforts focused on urban areas and critical facilities (hospitals, schools, and water pumping stations and filtration systems). Only minimal service had been restored, mostly to urban areas around San Juan, during the first few days of cleanup. After 2 weeks of repairs, approximately 1,200 megawatts of electricity were available. Prior to Hurricane Georges, Puerto Rico's 1.3 million electric customers used approximately 3,057 megawatts per day. With the assistance of extra crews and equipment, 92 percent of the customers served by the Puerto Rico Electric Power Authority (PREPA) had electrical service by the end of October. By mid-December, 100 percent of the electrical grid was restored and 97 percent of electrical customers had service.

In response to the needs of the Government of Puerto Rico, Federal assistance to the energy sector is focused on:

1. resources for repairing electrical transmission and distribution lines, and recommending design improvements;
2. supplying emergency generators; and
3. assistance for developing a more reliable electrical system.

Most of this assistance is oriented toward incorporating mitigation measures into the repair and restoration process and encouraging future design improvements.



Crews worked around-the-clock to restore service to nearly 1.3 million electric customers.

Repairing Electrical Transmission and Distribution Lines

29.0 Requirement: Provide assistance in restoring electrical service and protecting electric transmission and distribution lines.

29.1 Action: An estimated \$100 million is being provided by FEMA through its Public Assistance program to assist PREPA in restoring electrical service throughout the island. Federal assistance included flying in 300 electric utility workers, and trucks and equipment from Public Service of New Hampshire, Public Service of Connecticut, Long Island Electric, Niagara Mohawk Electric, and Duke Engineering and Services. These



Extensive support was brought from outside Puerto Rico to expedite the restoration of power.

workers assisted local crews in repairing the island's transmission and distribution lines and in restoring electrical service.

■ **29.2 Action:** DOE and FEMA are working with PREPA to repair the widespread damage to the island's electrical system. The Agencies identified a number of mitigation improvements that will yield a transmission and distribution system that is more hurricane resistant. Technical advisors are working with PREPA and contractor crews to make these design improvements as part of the ongoing transmission and distribution line repairs. FEMA-funded mitigation repairs include:

- • adding a cross brace ("X" brace) to transmission and distribution line H-frame structures; and
- • placing poles deeper in the ground. Many of the damaged wood poles were pulled out of the ground by the hurricane. The minimum hole depth for poles should be 10 percent of the pole's length plus 2 feet.

The Task Force also encouraged PREPA to implement three additional design improvement recommendations. They are:

- • replacing older, insect-damaged wood poles and corroded metal towers. New poles and structures are more resistant to hurricane damage;
- • conducting a study to determine what caused rectangular concrete poles to fail during the hurricane. Rectangular poles are subject to much heavier wind loading. Round concrete poles used in locations with similar conditions to Puerto Rico had a low failure rate after being struck in 1997 by a storm with sustained winds of up to 145 mph and gusts of up to 160 mph; and
- • reducing the wind load on poles by limiting the number of service systems (e.g., electric and telephone lines) that share each pole.



A mechanical hole-digger helps insure that new utility poles will be placed at the proper depth to resist future storms.

Emergency Generators

30.0 Requirement: Provide emergency generators for critical facilities.

■ **30.1 Action:** FEMA is working with the Government of Puerto Rico to develop a plan to provide emergency power for critical facilities. Many critical facilities, such as water pumping stations, suffered little damage and would have been operational immediately following the hurricane if the electrical system had not failed. The Federal Government provided 283 emergency generators, which were installed at critical facilities to get them back in service. The plan being developed will allow these generators to remain in Puerto Rico to provide emergency power for critical facilities. Keeping these generators on-site, or the purchase and installation of permanent emergency generation will increase the reliability of these critical facilities during future disasters.

Developing a More Reliable Electrical System

31.0 Requirement: Provide assistance to ensure future reliability of the electrical system.

■ **31.1 Action:** FEMA and DOE will continue to work with PREPA and the Government of Puerto Rico to implement additional measures to improve electrical service reliability in the future. For example, FEMA is working with PREPA to provide mitigation funding for multiple alternate feeder (“looping”) rights-of-way. While looped feeders would not have prevented the initial blackout in Puerto Rico during Hurricane Georges, looped feeders will permit quicker restoration of electric service after future disasters.

DOE and FEMA also recommend that PREPA consider conducting a study of each new power line to determine if it should be located above or below ground.

Background

Hurricane Georges caused severe damage to most of Puerto Rico's highway system, which includes approximately 7,000 kilometers of roads and 2,100 bridges. Puerto Rico's roads were generally in good condition and well maintained prior to the storm. The Puerto Rico Department of Transportation and Public Works (PRDTPW) was in the process of an aggressive transportation program to modernize its primary highway system, relieve urban congestion, and improve roads to towns in the mountains. The PRDTPW was also working on a bridge replacement program to improve 230 bridges that are structurally deficient and approximately 100 bridges that may be susceptible to erosion.

The impact of Hurricane Georges on the island's roads and bridges included: large amounts of debris blocking roads and drainage systems; the collapse of retaining walls; structural damage to bridges; landslides; pavement and embankment failures; and damage to signs and signal systems. An estimated 40 bridges and low crossings were damaged; 9 bridges suffered major structural failure or collapsed.

Immediately following the hurricane, PRDTPW launched a massive emergency response effort to open highways to essential travel and to safeguard the infrastructure from further damage. More than 230 PRDTPW crews and 30 contractors participated in the effort. USACE removed tons of debris from roadways and installed four temporary bridges. Within a few days most highways were open to traffic. Only 10 short sections of roadways and 2 bridges remained closed at the end of October.

The Federal Government has been quick to provide the Government of Puerto Rico assistance to restore the island's transportation system. Assistance has focused on:

1. repairing damaged roads and bridges;
2. developing a reliable power source for the Tren Urbano project; and
3. dredging harbors.

FEMA assistance is focusing heavily on incorporating mitigation measures into road and bridge repairs to reduce the risk of such severe damage in the future.



A truck drives over a temporary bridge erected adjacent to a storm-damaged bridge.

Repairing Roads and Bridges

32.0 Requirement: Provide assistance for repairing highways and bridges, and for related mitigation projects.

■ **32.1 Action:** FEMA and DOT will provide an estimated \$55 million to assist Puerto Rico in repairing damage to its highways and bridges, which were severely damaged by the storm. Highway infrastructure, in general, has a high failure rate during hurricanes. The estimated \$55 million in



Storm damage rendered many roads impassable.

■ assistance includes FEMA HMGP funding for eligible mitigation measures. The Government of Puerto Rico is responsible for establishing priorities for the use of HMGP funds.

■ **32.2 Action:** FHWA currently estimates providing \$35 million for repairs to Federally funded highways. In-kind restoration is the predominant type of repair normally funded under DOT’s FHWA Emergency Relief (ER) program. However, mitigation measures that can be economically justified may also be eligible for funding. More than \$11 million in ER funds have already been provided. FHWA is also working with PRDTPW to make the necessary bridge replacements and repairs as quickly as possible. FHWA will continue to work closely with its Puerto Rico counterparts to evaluate projects, including the eligibility and feasibility of mitigation.

■ **32.3 Action:** FEMA will provide an estimated \$20 million through its Public Assistance Program to assist in the repair and reconstruction of public roads and bridges that are not Federally funded. This estimate includes funding for mitigation projects that will incorporate current codes and standards into the repairs, and the implementation of Minimum Road Standards (MRS) adopted by the 78 municipalities.

Reliable Power for the Tren Urbano Project

33.0 Requirement: Explore options for funding a reliable power source for the San Juan Tren Urbano project.

■ **33.1 Action:** The FTA is working with the Government of Puerto Rico to fund a reliable power source for the Tren Urbano project. Tren Urbano is a 10.7-mile, 16-station rapid rail line. It will connect three municipalities and run between Bayamon Centro and the Sagrado Corazon area of Santurce in metropolitan San Juan. The project has been selected as one of FTA’s turnkey demonstration projects. The \$1.55 billion system is scheduled to open in 2001.

■ Hurricane Georges has highlighted the need to incorporate an uninterruptable power source into the design of the project to reduce the vulnerability of the system to disasters. The FTA is actively pursuing several funding options, which include reprogramming existing appropriations and exploring the use of FEMA HMGP funds. The FTA will continue to work with the Government of Puerto Rico to address this need.

Dredging Harbors

34.0 Requirement: Provide assistance to clear debris from harbor channels.

■ **34.1 Action:** USACE will spend \$11 million to carry out critical dredging activities and other harbor channel repairs needed as a result of Hurricane Georges. The navigation projects identified for dredging are located in the following harbors: Aguadilla, \$1 million; Arecibo, \$2 million; San Juan, \$6 million; and Fajardo, \$2 million.

